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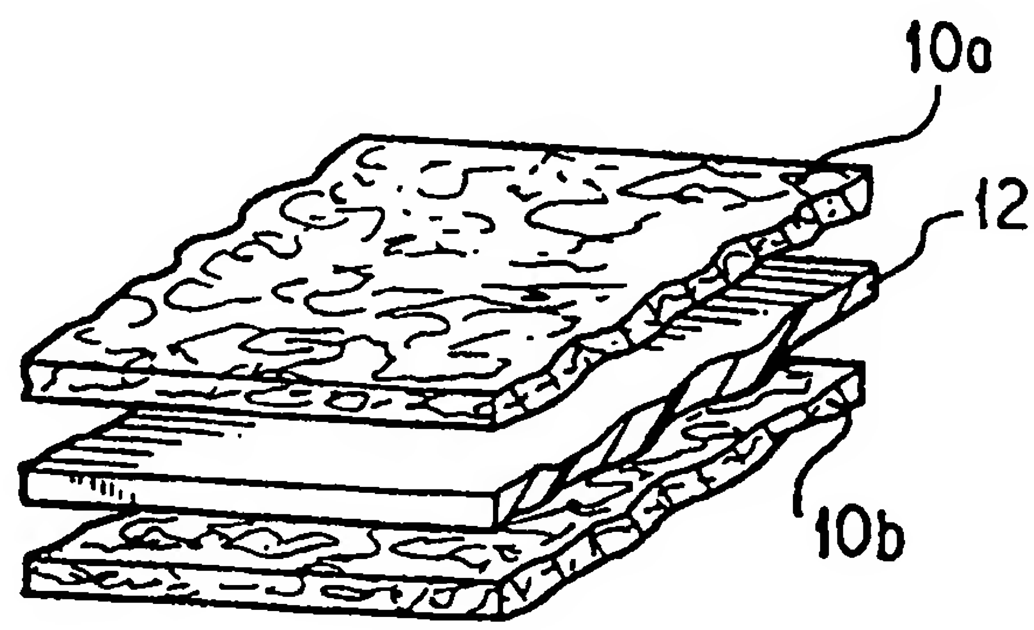
(54) Title: NONWOVEN COMPOSITE LAMINATE FOR CLEANING PADS AND WIPES

(57) Abstract

A nonwoven composite combines a support layer (12) with at least one carded fiber layer, and the combined layers are thermally bonded together between calendar rolls. In one preferred embodiment, the support layer consists of a prebonded thermal-bond nonwoven which provides a softer, more drapable hand. In a preferred trilaminate wipe product, the carded fiber layers (10a and 10b) are comprised of a blend of absorbent, resilient and soft fibers. In a preferred bilaminate skin care product, the carded fiber layer is bonded with a different bond pattern than that of the prebonded thermal-bond support layer, to produce a dual textured product.



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NON-WOVEN COMPOSITE LAMINATE FOR CLEANING PADS AND WIPES

SPECIFICATION

This patent application is a continuation-in-part of commonly owned U.S. Patent Application No. 08/869,809 entitled "High Strength Baby Wipe Composite", filed on June 5, 1997.

Technical Field

This invention generally relates to a composite laminate structure for a nonwoven product, and more particularly, to a nonwoven product produced by thermally bonding nonwoven web(s) of fibers with a support layer.

Background of Invention

For cleaning pads and wipes, it is desirable to have a nonwoven product fabricated with soft, lofty, and absorbent surface fibers combined with good dimensional stability and tear strength for cleaning applications. Two applications of particular interest are for skin care cleaning pads and baby wipes.

In an acne pad application, a widely used nonwoven is the NOVONETTE™ fabric grades sold by International Paper Company, Veratec Division, of Walpole, Massachusetts. The NOVONETTE™ fabric is produced by a process referred to as the "Novonette Process" described in U.S. Patent No. 3,507,943, now expired. The nonwoven product is formed by passing a sheet of carded web weighing 75 gsy, consisting of 75% rayon and 25% polypropylene fibers, between a pair of heated calender rolls, both engraved with a pattern of lands and grooves. The calender rolls have land/groove patterns in the form of a series of helices. When a carded web is passed through these calender rolls, a repeating pattern of

quadrilateral pressure areas is generated where some fibers are permanently displaced, formed by the traverse of a land area of one roll over a land area of the other roll, as the rolls are rotated. Due to the effect of the heated calender rolls, bond sites are generated at the high pressure areas. The resulting thermal-bonded nonwoven is formed with a ridge-like texture on both sides. This nonwoven product is suitable for an acne pad application because of its unique texture and high absorbency characteristics.

Nonwoven products for skin care applications can also be produced by ultrasonically bonding two nonwoven webs in a laminate structure. In one skin care wipe material, a hydroentangled nonwoven web having fiber composition of 50% rayon fibers, 30% polyester fibers and 20% polypropylene fibers is bonded to a chemically bonded nonwoven web having a composition of 75% polyester fiber and 25% latex binder. In another skin care wipe material, a hydroentangled web having a fiber composition of 100% polyester fiber is bonded to a thermally bonded nonwoven web having a fiber composition of 80% polyester fiber and 20% polyester binder fibers. These skin care wipes are die cut in stacks and put in jars where they are soaked in an aqueous solution containing skin treatment chemicals.

These current products have the following problems which the present invention seeks to overcome. Current NOVONETTE™ grades made by the conventional process have a severe disadvantage regarding production speeds for a heavy weight wipe material (weighing more than 65 gsy). The heavy weight web in the range of between 65 - 130 gsy needs to be bonded in one bonding step using a heated calender roll. The heavy weight of the product limits production speeds to about 100 - 125 fpm. This reduces the production efficiencies of the material and drives the product costs up. Also, since the wipe materials are only bonded in a single step, using this method, a high amount of cellulosic fiber in the structure leads to less fiber tie down. The resulting product can become more fuzzy

and loose in wet conditions during use.

Additionally, ultrasonic bonding is a relatively slow process. Typical speeds for making skin care products are limited to 15 - 50 fpm. Therefore, this process is very expensive. Moreover, materials used from different nonwoven processes are often available in different widths leading to a lot of wastage. Also the hydroentanglement process used for making at least one of the nonwoven layers used in many of the products is very expensive, leading to an overall increase in product cost. All the wipe materials made using ultrasonic bonding require at least two nonwoven webs which are produced in separate processes, including hydroentanglement, chemical bonding and thermal bonding. The nonwoven layers are then ultrasonically bonded together in a third step.

In the prior copending Application No. 08/869,809, an improved laminate product is produced by combining a supporting prebonded nonwoven fabric of spunbond (SS) or spunbond-meltblown-spunbond (SMS) layers thermally bonded together, with two layers of carded fibers on either side of the prebonded nonwoven fabric and thermally bonding them together in a composite structure through the use of heated calender rolls. The SS or SMS nonwoven consists of 100% polypropylene fibers. The carded webs can comprise fibers selected from the group consisting of polypropylene, rayon, polyester, polyethylene, and cotton and blends thereof. However, for some applications, for example, acne pads and baby wipes, this product is not perceived to be soft enough and results in a non-textile like, plastic or synthetic hand. It also does not have the required thickness and provides less than the required absorbency.

It is therefore desirable to produce a composite laminate product that has a softer, more drapable hand. For baby wipes and acne pads, it is desirable that the outer fibers be absorbent, resilient, and soft. For acne pads, it may be desirable that the product have dual sided properties, for example, for applying cleaning lotion and

scrubbing, or that it have dual textured sides. Another desirable property is to have different colors on each side. The color difference should be maintained when the cleaning pads are immersed in liquid.

Summary of the Invention

In accordance with the present invention, a nonwoven composite laminate comprises a previously bonded (prebonded) nonwoven fabric as a support layer, combined with a carded fiber layer on one or both outer sides of the support layer, wherein the combined layers are thermally bonded together between heated calender rolls so that at least the prebonded nonwoven fabric has been twice subjected to bonding processes. This allows the bonding of the composite to be obtained at lower bonding temperatures and at higher production speeds, and with better tie down of fibers.

In a preferred trilaminate product for acne pad applications, the support layer is a prebonded thermal-bond nonwoven which provides a softer feel and hand, and is composed of a substantial portion of rayon fibers with other fibers. This enables the outer carded fiber layers to have a lower percentage of rayon fibers for reduced fuzz generation while maintaining the high absorbency characteristics of the wipe.

In a preferred trilaminate product for baby wipe applications, the support layer is a prebonded thermal-bond nonwoven, and the carded fiber layers are comprised of a blend of absorbent, resilient and binder fibers. The thermal-bond nonwoven support layer provides a softer, more drapable wipe as compared to products that use spunbond or spunbond-meltblown-spunbond nonwovens as the support layer.

A preferred bilaminate product for skin care applications, comprises a support layer that is a prebonded thermal-bond nonwoven, and one layer of carded fibers that is thermally bonded to the support layer with a different bond pattern than that of the prebonded thermal-bond

nonwoven, to produce a dual textured product.

In another preferred trilaminate product for acne pad applications, a prebonded nowoven fabric, such as thermal-bond, spunbond or SMS fabric, is combined with one carded web containing a blend of fine denier, absorbent fibers on one side and another carded web having a majority of coarse denier, non-absorbent fibers on the other side, thus providing a dual-sided product. The smooth side contains a significant amount of absorbent fibers and can be used as the applicator side for cleaning lotion. The coarser side, containing a large amount of non-absorbent, high denier fibers retains a relatively low amount of cleaning liquid and can be used as a scrubbing side.

In another preferred trilaminate product for acne pad applications, an apertured film is used as the support layer with the carded fiber layers on either side, resulting in a soft product having a textile-like feel on both sides. Different colored fibers may be used in the carded fiber layer on one side to provide a dual colored product. The apertured film does not absorb liquid and maintains its opacity when immersed in liquid so that the two sides remain distinct in appearance.

Other objects, features, and advantages of the present invention will be explained in the following detailed description of the invention having reference to the appended drawings.

Brief Description of the Drawings

FIGS. 1A, 1B and 1C illustrate the thermal bonding of nonwoven layers into a composite laminate for the general example of a trilaminate product.

FIG. 2 is a schematic diagram showing a process line for the manufacture of a thermally bonded composite laminate of a prebonded support layer with carded fiber layers in accordance with the present invention.

FIG. 3A is a schematic diagram showing a sectional view of a calendar roll surface used for thermal bonding of

composite layers.

FIG. 3B is a schematic diagram showing the arrangement of circular bond point lands in a hexagonal pattern on the surface of the calendar roll of FIG. 3A.

FIG. 4A is a schematic diagram showing an arrangement of lands and grooves in a helical pattern on the surface of a calendar roll used for thermal bonding of composite layers.

FIG. 4B is a schematic diagram showing a sectional view of a portion of the calendar roll of FIG. 4A.

FIG. 5 is a diagram of a "Slash Pattern" used as a bonding pattern for thermal bonding of composite layers.

Detailed Description of the Invention

The prior copending Application No. 08/869,809 disclosed a process for producing an improved laminate baby wipe product by combining a prebonded spunbond (SS) or spunbond-meltblown-spunbond (SMS)layer with two layers of carded fibers on either side of the prebonded nonwoven layer and thermally bonding them together in a composite structure through the use of heated calender rolls. The general bonding process is described below insofar as it is similarly used in the present invention for making improved types of composite laminates. Reference is made to the prior application for a more complete description of this bonding process.

A one-step bonding process is used for manufacturing a nonwoven composite using thermal bonding (heated calender) technology. The nonwoven composite is produced by combining one or two nonwoven layer(s) of fibers with a prebonded support layer in a laminate. Bonding the prebonded support layer between two nonwoven fiber layers results in a "trilaminate" product. A "bilaminate" composite is made by bonding one nonwoven fiber layer to the prebonded support layer.

An example of the general process for forming a composite laminate product in accordance with the invention

is illustrated in FIGS. 1A - 1C. One or two outer nonwoven fiber layers 10a, 10b and a prebonded support layer 12 are fed in superposed relation through the nip of a pair of heated calender rolls 20a, 20b. One or both of the calender rolls may be patterned with calendering points or lands. As shown in FIG. 1B, when two patterned calendar rolls with lands in registration are used, the opposing lands 22a, 22b apply heat and pressure in the compressed areas causing the fibers of the webs 10a, 10b to bond together and to bond to the support layer 12. As shown in FIG. 1C, the laminate becomes thermally bonded with bond indentations 30 in the outer surfaces 32 of the nonwoven layers 10a, 10b. The result is that the layered structure is thermally point bonded with a textured surface.

In FIG. 2, a process line is shown schematically for the manufacture of a laminate as a continuous roll product. The fibers of the outer layers are carded at card stations #1 and #2 and fed on card conveyors 14a, 14b, respectively, for the webs 10a, 10b of fibers. The prebonded support layer 12 is unwound as roll stock from an unwind stand 16 and fed in superposed relation between the two carded webs on the card conveyors 14a, 14b, and the composite is fed by conveyor 17 to hot calender rolls 20a, 20b to be thermally bonded and textured. Although FIG. 2 shows dual engraved calender rolls 20a, 20b, it is within the scope of this invention to form the composite product using a single engraved calender roll on the top 20a or on the bottom 20b with a smooth roll on the other side. On entering the heated calender rolls, the fibers in the carded layer(s) 10a, 10b are bonded together and to the prebonded support layer 12 at the raised lands 22a, 22b to form a textured surface pattern. On exiting the calender rolls, the bonded and textured nonwoven composite is wound up on a roll.

The temperature of the calender rolls may range from 250 - 600 degrees F, preferably 300 - 400 degrees F. The pressure between the top and bottom rolls may be in the

range of 100 - 1200 pounds per linear inch (pli), preferably about 100 - 1000 pli. The line speed may be in the range of 50 - 600 feet per minute (fpm). Samples were produced at a line speed of 70 - 200 fpm. The bond pattern on either or both of the calender rolls can have any one of a number of different geometries including, but not limited to, Novonette #1, Novonette #2, Novonette #4, a "Slash" pattern, and a repeating 7-dot pattern. The bond area can be varied in the range of 5 - 50%.

In a preferred configuration, the dual engraved calender rolls are each engraved with a helical pattern of lands and grooves with a bond area of about 38% (the Novonette #4 pattern). Novonette #1 and #2 calender patterns produce fabrics having a bond area of about 27% and 25%, respectively. In Fig. 4A, the lands of the bond pattern are shown arranged in diagonal lines on the calendar roll so that they are impressed on the laminate at a given helical angle. Fig. 4B shows the lands of the bond pattern in side sectional view with slightly inclined walls (here 14.5 degrees of incline on each side) and having a given pitch spacing P and land width LW. The lands may be generally defined as a spaced set of parallel ellipsoids extending equidistant from the axis of the rolls and in a plane which is inclined relative to the roll axes. The overall character of the bond area and fiber-displacement pattern will comprise three components: a highly compacted area where a land has traversed a land; more lightly compressed areas where a land on one roll has traversed a groove on the other roll; and a substantially unaffected are where a groove on one roll has traversed a groove on the other roll. The degree to which these areas are permanently impressed onto composite fabric material processed between such rolls will depend on the thickness of the composite fabric material, its nature and the pressures and temperatures used in processing. Novonette calendering rolls are disclosed in U.S. Patent No. 3,507,943 to Such et al., which is incorporated herein by reference.

In another configuration, one calendar roll (either top or bottom) has a bond pattern which is a repeating 7-dot pattern wherein each repeating unit of the bond pattern comprises circular bond spots arranged with their centers at the vertices of a regular hexagon. The other calender roll is smooth. The geometry of the lands of the engraved roll is shown in FIG. 3A. As seen in FIG. 3B, each repeating unit of the bond pattern is arranged in a hexagonal fashion. The hexagonal unit is repeated at a distance of 0.261 inch in the machine direction and a distance of 0.463 inch in the cross direction. Each hexagonal unit consists of a circular bond spot of 0.48-inch diameter at the center surrounded by an outer array of six circular spots of the same diameter at the vertices of a hexagon. The center-to-center distance of the outer array of circular spots is 0.949 inch. The outer circular spots are also radially spaced at a distance of 0.094 inch from the central circular spot. The aforementioned 7-point dot bond pattern has a total of 115 bond spots per square inch, resulting in a total bond area of 19.1%.

The fibers of the carded nonwoven layer(s) are preferably made of absorbent, resilient and binder fibers including thermoplastic fibers, for example, polypropylene, polyester, polyethylene, or blends thereof. Cellulosic fibers (e.g., rayon or cotton) may also be blended with the thermoplastic fibers. Carded nonwoven layers in accordance with this invention each have a basis weight in the range of 5 - 60 grams per square yard (gsy), preferably 12 - 45 gsy, and a thickness of 5 - 50 mils as measured using a Thwing-Albert loading at 0.21 psi. A listing of several preferred fibers and their properties is given in Tables 4, 5 and 5A.

For a skin care product made in accordance with the present invention, the calendar bonding process line as shown in Fig. 2 is fed with a prebonded thermal-bond nonwoven fabric used as the support layer 12. One layer of carded fibers can be combined on one side of the prebonded thermal-bonded nonwoven to form a bilaminate product, or two

layers may be combined with a thermal-bond nonwoven to form a trilaminate product. The thermal-bond nonwoven can be previously bonded on the same bonding line, thereby producing a support layer of the same dimensions that will be used for the second, composite bonding step. The calender rolls can have any geometries including, but not limited to, the Novonette #4, Novonette #2, Novonette #1, repeating 7 pt. dot pattern and Slash pattern. The total bond area can be varied in the range of 5 - 50%. Examples of products produced by this process for skin care applications are given below.

Example I: Soft Acne Pad Trilaminate

An acne pad trilaminate was made by the thermal bonding process combining a prebonded thermal-bond nonwoven as the support layer with a blend of absorbent and resilient fibers for the outer layers. Specifically, thermal-bond nonwoven roll stock was introduced between two layers of carded webs composed of absorbent, resilient and binder fibers blended together. The composition and physical properties of two composite examples are summarized in Table 1. In the two trials, different fiber blends were used in the top and bottom layers. However, the same blend composition may be used on both sides.

In these examples, the support layer was composed of a blend of rayon and thermoplastic fibers thermally bonded together. A higher percentage of rayon fibers was used in the support layer as compared to the two outer layers. This allowed the product to maintain high absorbency and softness, while fuzz generation on the surface is reduced (more rayon on the surface tends to generate more fuzz). The sink time performance was also good.

The above trials were conducted with calendar rolls having a Novonette #4 bond pattern, using two helically engraved rolls and providing a high bond area of about 38% of the total area. Of course other Novonette bond

patterns can also be used to make a similar product. Use of the Novonette bond pattern is desirable since it produces texture on both sides of the acne pad. A high bond area such as produced in the Novonette #4 pattern has the added advantage of reducing the fuzz level. Other types of calendar roll patterns, such as 7 pt. dot pattern, Slash pattern, etc., may be used. The latter patterns employ one engraved roll and one smooth roll, with either of the rolls capable of being placed in the top or bottom positions. Many other types of calendar roll patterns could be used.

Example II: Dual Sided Acne Pad Trilaminate

An acne pad trilaminate was made by combining a prebonded support layer of thermal-bond or spunbond nonwoven with different blends of absorbent and resilient fibers on the outer sides. A blend of fine denier, absorbent and resilient fibers was used on one side to provide a smooth texture. Non-absorbent, high denier fibers were used on the other side to give it a coarse texture. The smooth side contained a significant amount of absorbent fibers for its function as the applicator side for cleaning lotion. The coarser side, contained a large amount of non-absorbent, high denier fibers which retained a relatively low amount of cleaning liquid for its function as a scrubbing side. The composition and physical properties of two composite examples are summarized in Table 2.

The thermal-bond trilaminate in Example I is much softer than conventional (single-step, heavy weight) nonwoven cleaning pads and the cost of the materials is much less, making it more economic. The dual sided pad in Example II offers a unique combination of dual functionality by incorporating a soft and a coarse side. One side is useful in applying the cleaning lotion and the other side is useful for scrubbing purposes but still is gentle on the skin. In one composite example, the use of EVERSPUN™ spunbond as the support layer resulted in a deep embossed look enhancing the texture of the product. It also

increased the strength of the product considerably in both the MD and CD directions. Use of 6 denier (6.7 dtex) polypropylene fibers on one side of the acne pad substrate provides a comparatively coarse side for scrubbing. The other side had 2 denier (2.2 dtex) HY-COMFORT™ fibers that provided a softer hand. Colored fibers can also be used on either side to create a visual difference between the two sides.

Example III: Dual Textured Acne Pad Bilaminate

An acne pad bilaminate was made by calendar bonding a prebonded thermal-bond nonwoven as the support layer with a blend of absorbent and resilient fibers on one side only. The calendar rolls used a 7 pt. dot pattern, with the engraved roll on the side of the top layer and a smooth roll on the side of the support (or bottom) layer. The thermal-bond nonwoven had a different bond pattern (Novonette #4) than the 7 pt. dot pattern used on the top side in order to provide different textures on the two sides of the product. The composition and physical properties of three composite examples are summarized in Table 3. The dual textured feel and aesthetic appearance provide the product with competitive advantages in the market for acne pads.

Example IV: Baby Wipe Composite With Thermal Bonded Tie Layer

A softer, more drapable baby wipe was made using the laminate calendaring process by combining a layer of prebonded thermal-bonded nonwoven fabric with a blend of absorbent, resilient and soft fibers on both sides. In the examples, the thermal-bond nonwoven was made of polypropylene fibers and had basis weights of 15.7 and 16.1 gsy. However, thermal-bond nonwovens having basis weights from 8 to 30 gsy can be used. The prebonded thermal-bonded nonwoven was introduced in between two layers of carded fibers comprising a blend of absorbent, resilient, and binder fibers. The composition and properties of examples

of the baby wipes made are summarized in Tables 6 and 7. The composition and physical properties of baby wipes having an SMS support layer (in accordance with the prior patent application) are summarized on Table 8 for comparison.

Significant improvements in softness and drapability were obtained. The SMS-based wipe had higher drape values (was stiffer) in both the MD and CD than the samples made with the thermal-bond support (tie) layer. The thermal-bond samples also evidenced a softer hand which can be attributed to the thermal-bond material and the lower basis weight in some examples of the composite. The SMS-based wipe had higher tensile strength for the same or higher basis weights. In general, all four examples having the thermal-bond tie layer exhibited very good absorbency. The sink times do not play a significant part in the performance of these wipes because they are sold as wet wipes.

In the above-described examples, the calendar pressures were varied from 100 - 1000 lb/in (pli), with 250 pli being the preferred pressure on the pilot calendar. The temperatures of both the top and bottom rolls were varied from 250 - 500 degrees F, with the preferred range being from 300 - 400 degrees F. Since the support layer is prebonded, the carded fiber layer(s) can be thermally bonded to the support layer at lower temperatures and pressures, thereby allowing the production speeds to be operated higher than would be required for a laminate of nonwoven fiber layers of comparable weight.

Other combinations of bond patterns, different blends, types and compositions of fibers, such as polypropylene, polyester, nylon, rayon, cotton, and bicomponent fibers, and a wide range of other nonwovens, such as hydroentangled, chemical bonded, and spunbond or SMS nonwovens, can also be used. For specific applications, specially chosen types of polyester, polypropylene, and rayon fibers may be used for the carded webs. Some examples of other types of fibers that may be used for baby wipes or

skin care products are summarized on Table 4. An especially good material for skin care applications and baby wipes is HY-COMFORT™ polypropylene fiber obtained from Fiber Visions, of Athens, NC, and its properties are summarized on Tables 5 and 5A. Other variations of fibers, fiber blends, thermal-bond support layer, and calendaring patterns for baby wipes are summarized on Table 9.

The baby wipe trilaminate composite having the thermal-bond support layer have a unique texture and appearance in wet condition, and also has significantly improved softness and drapability as compared to the prior SMS-based trilaminate. The baby wipe examples of the invention showed superior strength as compared to the properties of other baby wipe composites summarized in Table 10. The improved softness coupled with high tensile strength are considered to provide competitive advantages over conventional products and SMS middle layer products of the prior art.

For skin care applications, it is also desirable to provide a dual color skin care wipe product. It is important for the dual color wipe to maintain its dual color appearance after it is saturated in cleaning liquid, since the product is sold in a wet state saturated with lotion. Another important consideration is that the product should allow the liquid to penetrate the wipe easily, since the wipes are usually die cut in a dry state, then stacked in jars and immersed in cleaning lotion filled from the top. Easy penetration through the wipes ensures complete wetting of the whole stack. However, prior attempts to produce a dual color product with a white side and a colored side have not been successful, because as soon as the composite is saturated with liquid, the white side loses its opacity allowing color to show through from the colored side, and the whole composite then appears to have one color.

In another preferred embodiment of the invention, a dual color composite is produced by combining a carded layer of fibers on one or both sides with an apertured film

and thermally bonding the composite between heated calendar rolls as described previously. In the preferred embodiment, the apertured film is sandwiched between two carded fiber layers, resulting in a soft product having a textile-like feel on both sides. Different colored fibers are used in the carded fiber layer on one side to provide a dual colored product. The apertured film does not absorb liquid and maintains its opacity to a high degree in the wet state allowing the two sides of the product to remain distinct in appearance while saturated in liquid. Examples of the composite product are provided below.

<u>Example V: Dual Color Composite For Skin Care Cleaning Pads</u>

A trilaminate product is formed by combining an apertured film, such as CPT™, VISGARD™, or VISPORE™ polyethylene film from Tredegar Plastics, of Terre Haute, Indiana, with a carded web of white absorbent and resilient fibers, such as a blend of rayon and polypropylene fibers, on one side, and a carded web of blended fibers, such as blue, philic polypropylene fibers from Fiber Visions and white rayon fibers, on the other side. In the composite examples, the wipe was manufactured using a 1 mil (18 mil bulk) VISPORE™ apertured film sandwiched between top and bottom carded fiber layers and thermally bonded with a heated calendar roll with 7 pt. dot pattern. The carded fibers on the side bonded with the smooth roll had a composition of 40%, 1.5 denier x 40 mm COURTALDS™ Rayon 18453 and 60%, 2.2 dtex x 40 mm HY-COMFORT™ polypropylene fibers. The carded fibers on the engraved roll side was 80% HY-COLOR™ blue, philic polypropylene fibers and 20% Courtalds rayon fibers (18453 rayon, 1.5 den. X 40 mm). The composition and physical properties of the composite examples are summarized on Table 11.

The dual color wipe had a textile-like texture, provided absorbency, softness, and good cleaning ability, and maintained its dual color appearance when saturated with cleaning liquid. This was attributed to the masking effect

of the apertured film which does not absorb liquid yet allows liquid to wick through the composite at the same time. The macro holes in the apertured film allowed the lotion to penetrate the composite without difficulty. The apertured film can contain a white pigment to increase its masking of color. An unexpected benefit of using the apertured film in the middle is that the skin care wipes produced in this way were much bulkier than wipes produced without the film, thereby giving a richer feel to the wipe. Due to thermal bonding of the carded layers to the film, the wipes can also be die cut easily.

The calendar pressures used to produce the laminate can vary from 100 - 1200 pli, with a preferred range of 250 - 800 pli on the pilot calendar. The temperatures of the top and bottom rolls can vary from 250 - 500 degrees F, with the preferred range of 300 - 400 degrees F. The speed of the production line can vary from 50 to 600 ft/min. Other kinds of apertured films with different hole sizes, shapes, open area, and opacity can be used. Many other polymers and blends of polymers can also be used for the film. Other types of polypropylene, polyester, nylon, rayon, cotton, and bicomponent fibers, and blends may be used. Either or both sides of the wipe may be wholly or partially colored using colored fibers. The two sides can be designed to have different textures by using different combinations of fibers. For example, one side can be made soft and absorbent for applying skin care lotion, and the other side can be made coarser and less absorbent for scrubbing. Other types of calendar bond patterns may also be used.

In summary, the present invention provides several important advantages over conventional single-step laminate processes for heavy weight cleaning pads and wipes, as follows:

The present invention uses a single layer of an inexpensive prebonded material, such as thermal-bond, spunbond, or SMS fabric or plastic film, as the support

layer, which is combined with at least one layer of absorbent, resilient, and binder fibers in a second thermal bonding process. This allows the cleaning pads or wipes to be produced in one step, as compared to the two or three steps required in conventional ultrasonically bonded products.

The composite in the present invention can be thermally bonded at high speeds of 100 - 400 fpm, which is faster, and therefore lowers production costs, as compared to conventional ultrasonically bonded products. Moreover, the nonwoven for the support layer can be produced on the same production line as the composite, thereby ensuring the same width, hence less trim wastage.

The present invention is also more cost effective than producing a conventional NOVONETTE™ wipe of a heavy weight grade in a single bonding step, because it allows higher production speeds.

The products produced in accordance with the present invention are also softer because they can be produced at relatively low calender temperatures. The single-step heavy-weight NOVONETTE™ products require a very high calender temperature to bond a heavy nonwoven web in one step, resulting in a harsher hand.

Skin care wipes having a thermal-bond support layer are softer than products having a spunbond SS or SMS layer. The thermal-bond support layer is made of short length staple fibers providing less bending rigidity as compared to continuous fiber spunbond structures, thus resulting in a softer composite. Also, a high percentage of cellulosic fibers can be used in the support layer to enure softness, absorbency, and a textile like hand.

Products made with a softer feel and hand in accordance with the present invention can have a relatively low amount of cellulosic fibers in the outer layers (less than 60% overall), thus ensuring less fuzzing in dry as well as wet conditions.

Since at least the prebonded support layer is bonded twice in the present invention, good fiber tie down is ensured through the thickness of the wipe.

In the dual textured bilaminate product, the prebonded thermal-bond fabric can have a different bond pattern than the bond pattern of the calender roll used to laminate the composite. In this manner, a dual textured wipe can be produced which is aesthetically more pleasing.

In the dual sided trilaminate product, the prebonded support layer can be combined with a carded web on one side having fine denier and absorbent fibers, and a carded web on the other side having coarse denier and non-absorbent fibers, thus providing a dual sided product for dual functionality.

In the dual color trilaminate product, the apertured film as the middle layer allows the colors of the different sides to be maintained in the wet state, and the two sides may also be formed with different textures.

The composite wipe structures and their variations covered herein may be used for many wipe applications including, but not limited to, for industrial, personal care, medical, food service, and clean room wipes.

It is understood that many modifications and variations may be devised given the above description of the principles of the invention. It is intended that all such modifications and variations be considered as within the spirit and scope of this invention, as it is defined in the following claims.

TABLE 1: SOFT ACNE PAD TRILAMINATES

CALENDER PATTERN	Novonette 4	Novonette 4
Top Layer	20% Courtaulds 18453	30% Courtaulds 18453
	Rayon, 1.5 den x 40mm +	Rayon, 1.5 den x 40mm +
	80% Danaklon HyComfort	70% Danaklon HyComfort
	Polypropylene 2.2 dtex x 40 mm	Polypropylene 2.2 dtex x 40mm
Middle Layer	7 pt. dot. Thermal bond	Novonette 4 Thermal bond
	33 gsy (70% Courtaulds	32.5 gsy (60% Courtaulds
	Rayon 18453, 1.5 den x 40 mm+	Rayon 18453, 1.5 den x 40 mm+
	30% Danaklon HyComfort	40% Danaklon HyComfort
	Polypropylene 2.2 dtex x 40mm	Polypropylene 2.2 dtex x 40mm
Bottom Layer	50% Cortaulds 18453	50% Courtaulds 18453
	Rayon, 1.5 den x 40 mm+	Rayon, 1.5 den x 40mm+
	50% Danaklon HyComfort	50% Danaklon HyComfort
	Polypropylene 2.2 dtex x 40mm	Polypropylene 2.2 dtex x 40mm
Weight		
gsy	76	76.7
(gsm)	90.9	91.7
Caliper		
mils	37	35.4
(microns)	939.8	899.2
Dry Strip tensile		
MD, lb/in	10.85	11.36
(g/cm)	1,937.8	2,029.9
CD, lb/in	1.95	1.83
(g/cm)	348.4	328
Dry Strip elongation		
MD, %	26.2	25.3
CD, %	61.8	47.7
Absorbency		
sink time, seconds	3.01	2.81
absorbency, grams	42.67	47.35
absorbency, g/g	8.47	9.41

TABLE 2: DUAL SIDED ACNE PAD TRILAMINATES

CALENDER PATTERN	Novonette 4	Novonette 4
Top Layer	20% Courtaulds 18453	100% Danaklon HyComfort
	Rayon, 1.5 den x 40mm +	Polypropylene 6.7 dtex x 40 mm
	80% Danaklon HyComfort	
	Polypropylene 6.7 dtex x 40mm	
Middle Layer	7pt. dot Thermal bond	Everspun 24 gsy, spunbond
	33 gsy (70% Courtaulds	grade
	Rayon 18453, 1.5 den x 40 mm+	
	30% Danaklon HyComfort	
	Polypropylene 2.2 dtex x 40mm)	
Bottom Layer	50% Courtaulds 18453	50% Courtaulds 18453
	Rayon, 1.5 den x 40mm+	Rayon, 1.5 den x 40 mm+
	50% Danaklon HyComfort	50% Danaklon HyComfort
	Polypropylene 2.2 dtex x 40mm	Polypropylene 2.2 dtex x 40 mm
Weight		
gsy	79.1	102.9
(gsm)	94.6	123.1
Caliper		
mils	40	47.9
(microns)	1,016	1,216.7
Dry Strip tensile		
MD, lb/in	8.3	20.3
(gm/cm)	1,496.9	3,625.2
CD, lb/in	1.6	7.6
(g/cm)	272.16	1,357.2
Dry Strip elongation		
MD, %	26.4	60.1
CD, %	46.7	82.7
Absorbency		
sink time, seconds	2.02	29.05
absorbency, grams	37.76	28.89
absorbency, g/g	7.5	5.69

TABLE 3 : DUAL TEXTURED ACNE PAD BILAMINATES

CALENDER PATTERN	7 PT. DOT	7 PT. DOT	7 PT. DOT
Top Layer	50% Courtaulds 18453	50% Courtaulds 18453	50% Courtaulds 18453
	Rayon, 1.5 den x 40mm+	Rayon, 1.5 den x 40mm+	Rayon, 1.5 den x 40 mm+
	50% Danaklon HyComfort	50% Danaklon HyComfort	50% Danaklon HyComfort
	PP 2.2 dtex x 40 mm	PP 2.2 dtex x 40 mm	PP 6.7 dtex x 40 mm
Bottom Layer	42.5 gsy Lewisberg's	53.5 gsy, Novonette 4 Thermal	53.5 gsy, Novonette 4 Thermal
	Thermal bond, P8 grade	Bond (50% Courtaulds 18453	Bond (50% Courtaulds 18453
	201509199. (100% PP)	Rayon, 1.5 den x 40 mm +	Rayon, 1.5 den x 40 mm+
		50% Danaklon HyComfort	50% Danaklon HyComfort
		PP 2.2 dtex x 40 mm)	PP 2.2 dtex x 40 mm)
Weight			
gsy	74.3	83.5	92
(gsm)	88.9	99.9	110.1
Caliper			
mils	29.9	35.8	36.4
(microns)	759.5	909.3	924.6
Dry Strip tensile			
MD, lb/in	14	8.7	7.6
(g/cm)	2,493	1,548.3	1,355.4
CD, g/in	2.9	1.2	0.9
(g/cm)	525	214.3	167.9
Dry Strip elongation			
MD, %	47.1	22.7	21.3
CD, %	72.6	33.2	27.2
Absorbency			
sink time, seconds	2.83	3.07	2.51
absorbency, grams	41.06	44.64	43.39
absorbency, g/g	8.17	8.8	8.57

TABLE 4: OTHER CARDED WEB FIBERS

Fiber	Fartrel Type 672 Polyester	Herculon T117 Polypropylene	Herculon T116 Polypropylene	Fibra 14561 Rayon	Fibra 12653 Rayon	Fibra 20762 Rayon
0 of	1.5	2.00	2.20	2.00	1.50	5.50
Length (mm)	38.00	38.00	38.00	40.00	40.00	40.00
Tenacity	4.50	3.34	3.71	n/a	n/a	n/a
Elongation (%)	67.00	140.00	113.00	n/a	n/a	n/a
Crimps per inch	n/a	19.60	28.20	n/a	n/a	n/a
Finish (%)	Regular	0.99 Phillic	0.75 Regular	n/a	n/a	n/a

TABLE 5: HY-COMFORT POLYPROPYLENE FIBER

MEASUREMENT	UNITS	METHOD	RESULTS	DEV
Decitex	g/10,000 m	QA-001	2.2	=0.4
Tensile Stregnth	cN/tex	QA-002	19.0	=3.0
Elongation	%	QA-003	350	=70
Fiber Length	mm	QA-005	40	=4.0
Crimp Frequency	#/100mm	QA-006	55	=20
Spin Finish	%	QA-009	0.35	=0.10
Card Length	m	QA-010	2.0	=0.50
Moisture Content	%	QA-014	<1.5	
Absorbency Time	seconds	QA-015	<3.0	
Color CIE L a b	DE	QA-011	1N/A	

TABLE 6: BABY WIPE COMPOSITE WITH THERMAL BONDED TIE LAYER

CALENDER PATTERN	7- POINT	7- POINT
TOP LAYER	80% Danaklon	80% Danaklon
	Hycomfort polypropylene	Hycomfort polypropylene
	2.0 dpf X 40 mm+	2.0 dpf X 40 mm+
	20% Courtaulds	20% Courtaulds
	18453 Rayon	18453 Rayon
	1.5 dpf X 40 mm	1.5 dpf X 40 mm
MIDDLE LAYER	Veratec Thermal Bonded	Veratec Thermal Bonded
	polypropylene TB	polypropylene TB
	16.1 gsy hydrophilic	16.1 gsy hydrophilic
BOTTOM LAYER	80% Danaklon	80% Danaklon
	Hycomfort polypropylene	Hycomfort polypropylene
	2.0 dpf X 40 mm+	2.0 dpf X 40 mm+
	20% Courtaulds	20% Courtaulds
	18453 Rayon	18453 Rayon
	1.5 dpf X 40 mm	1.5 dpf X 40mm
Total weight, gsy	62.80	43.60
Caliper, mils	30.20	22.30
Absorbency- Basket Sink		
Absorbency, gm/gm	9.57	11.23
Sinktime, secs	3.44	3.73
Dry Strip properties:		
MD dry tensile, gms/in	7,634.00	5,371.00
MD dry elongation, %	64.90	63.90
CD dry tensile, gms/in	1,409.00	1.092.00
CD dry elongation, %	123.80	119.30
Drape and Stiffness:		
MD, cm	8.70	7.30
CD, cm	5.20	4.60
Fuzz: Fuzzside, mgs	2.70	2.50
Non-Fuzzside, mgs	2.10	1.40
Wet Strip properties:		
MD wet tensile, gms/in	8,434.00	5,957.00
MD wet elongation, %	70.50	67.40
CD wet tensile, gms/in	1,432.00	1,196.00
CD wet elongation, %	127.60	129.50

TABLE 7: BABY WIPE COMPOSITE WITH THERMAL BONDED TIE LAYER (con't)

CALENDER PATTERN	7-POINT	7- POINT
TOP LAYER	80% Danaklon	80% Danaklon
	Hycomfort polypropylene	Hycomfort polypropylene
	2.0 dpf X 40mm+	2.0 dpf X 40mm+
	20% Courtaulds	20% Courtaulds
	18453 Rayon	18453 Rayon
	1.5 dpf X 40 mm	1.5 dpf X 40 mm
MIDDLE LAYER	Veratec Thermal Bonded	Veratec Thermal Bonded
	polypropylene TB	polypropylene TB
	15.7 gsy hydrophilic	15.7 gsy hydrophilic
BOTTOM LAYER	80% Danaklon	80% Danaklon
	Hycomfort polypropylene	Hycomfort polypropylene
	2.0 dpf X 40 mm+	2.0 dpf X 40 mm+
	20% Courtaulds	20% Courtaulds
	18453 Rayon	18453 Rayon
	1.5 dpf X 40 mm	1.5 dpf X 40 mm
Total weight , gsy	61.70	43.20
Caliper, mils	30.70	23.10
Absorbency- Basket Sink		
Absobency, gm/gm	10.29	11.59
Sinktime, secs	2.76	3.00
Dry Strip properties:		
MD dry tensile, gms/in	7,972.00	5,867.00
MD dry elongation, %	74.10	71.70
Drape and Stiffness:		
MD, cm	8.50	7.30
CD, cm	5.80	4.40
CD dry tensile, gms/in	1,346.00	1,088.00
CD dry elongation, %	132.20	131.00
Fuzz: Fuzz side , mgs	3.60	2.20
Non-Fuzz side, mgs	1.80	1.40
Wet Strip properties:		
MD wet tensile, gms/in	8,427.00	6,136.00
MD wet elongation, %	73.40	68.70
CD wet tensile, gms/in	1,452.00	1,144.00
CD wet elongation, %	135.30	134.40

TABLE 8: BABY WIPE COMPOSITE WITH SMS TIE LAYER

CALENDER PATTERN	7 - POINT
TOP LAYER	80 % Danaklon
	Hycomfort polypropylene
	2.0 dpf X 40 mm +
	20 % Courtaulds
	18453 Rayon
	1.5 dpf X 40 mm
MIDDLE LAYER	Veratec Everspun
	polypropylene SMS
	10 gsy hydrophobic
BOTTOM LAYER	80% Danaklon
	Hycomfort polypropylene
	2.0 dpf X 40 mm +
	20% Courtaulds
	18453 Rayon
	1.5 dpf X 40 mm
Total weight, gsy	57.90
Caliper, mils	29.00
Absorbency- Basket Sink	
Absorbency, gm/gm	11.23
Sinktime, secs	3.73
Dry Strip properties:	
MD dry tensile, gms/in	6,352.00
MD dry elongation, %	60.90
CD dry tensile, gms/in	1,427.70
CD dry elongation, %	70.00
Drape and Stiffness:	
MD, cm	9.30
CD, cm	5.70
Fuzz: Fuzz side, mgs	2.10
Non-Fuzz side, mgs	1.13
Wet Strip properties:	
MD wet tensile, gms/in	6,566.30
MD wet elongation, %	63.90
CD wet tensile, gms/in	1,490.30
CD wet elongation, %	69.30

TABLE 9: BABY WIPE COMPOSITE , OTHER VARIATIONS

CALENDER PATTERN	7- POINT	NOVONETTE # 4
TOP LAYER	20-70% Danaklon	20 - 70 % Danaklon
	Hycomfort polypropylene	Hycomfort polypropylene
	2.0 dpf X 38 mm	2.0 dpf X 38 mm
	+ 10 - 40% Wellman Fortrel	+ 10 - 40 % Wellman Fortrel
	Type 472 polyester	Type 472 polyester
	1.5 dpf X 38 mm	1.5 dpf X 38 mm
	+ 20 - 40% Courtaulds	+ 20 - 40% Courtaulds
	18453 Rayon	18453 Rayon
	1.5 dpf X 40 mm	1.5 dpf X 40 mm
MIDDLE LAYER	Thermal Bonded Nonwovens	Thermal Bonded Nonwovens
	polypropylene	polypropylene
	8 gsy to 30 gsy	8 gsy to 30 gsy
BOTTOM LAYER	20 - 70 % Danaklon	20 - 70 % Danaklon
	Hycomfort polypropylene	Hycomfort polypropylene
	2.0 dpf X 38 mm	2.0 dpf X 38 mm
	+10 - 40% Wellman Fortrel	+ 10 - 40 % Wellman Fortrel
	Type 472 polyester	Type 472 polyester
	1.5 dpf X 38 mm	1.5 dpf X 38 mm
	+ 20- 40% Coutaulds	+ 20 - 40 % Courtaulds
	18453 Rayon	18453 Rayon
	1.5 dpf X 40 mm	1.5 dpf X 40 mm
Total weight, gsy	30-80	30-80

TABLE 10: COMPARISON TO OTHER BABY WIPE COMPOSITES

MEASUREMENT	Prod. A	B	C	D	E	F	G
Weight							
gsy	54.60	45.40	52.00	67.30	52.60	60.90	56.80
(gsm)	65.30	54.30	62.20	80.50	62.90	72.80	67.90
Caliper							
mils	26.90	17.80	24.30	33.20	22.80	21.90	21.50
(microns)	683.30	452.10	617.20	843.30	579.10	556.30	546.10
Dry Strip tensile							
MD, g/in	940.00	1,985.00	787.60	587.60	944.30	7,856.00	7,231.00
(g/cm)	370.10	781.50	310.10	231.30	371.80	3,092.90	2,846.80
CD, g/in	365.10	463.20	675.80	310.20	538.40	2,407.00	3,230.00
(g/cm)	143.70	182.40	266.10	122.10	212.00	947.60	1,271.70
Dry Strip elongation							
MD, %	5.90	11.30	13.30	16.10	11.90	23.90	25.00
CD, %	13.80	31.70	20.50	30.10	19.40	105.50	75.60
Wet Strip tensile							
MD, g/in	498.10	1,345.00	357.00	706.40	330.50	6,065.00	6,038.00
(g/cm)	196.10	529.50	140.60	278.10	130.10	2,387.80	2,377.20
CD, g/in	197.60	295.90	302.50	302.70	300.30	2,310.00	2,799.00
(g/cm)	77.80	116.50	119.10	119.20	118.20	909.40	1,102.00
Wet Strip elongation							
MD, %	8.10	13.70	16.30	16.10	15.00	20.10	25.00
CD, %	18.70	38.00	22.50	35.40	22.50	94.30	81.70
Fuzz, mg (Dry sample)							
Fuzz side only	5.10	1.50	0.20	4.60	0.20	3.10	0.70
Absorbency							
sink time, seconds	3.73	13.27	2.25	2.18	1.99	1.56	1.66
absorbency , g/g	10.39	8.77	10.08	11.03	9.08	7.92	7.95

TABLE 11: DUAL COLOR COMPOSITE FOR SKIN CARE CLEANING PADS

CALENDER PATTERN	7- POINT DOT
TOP LAYER	80% Fiber Visions, HY-COLOR
	Blue, Phillic Polypropylene,
	3.1 dtex X 40 mm
	+ 20% Courtaulds 18453
	Rayon, 1.5 den X 40 mm
MIDDLE LAYER	X-6910 VitSPORE Film from Tredegar, 1.0 mil
	18 mil Bulk, 21.3 Gsy, White
BOTTOM LAYER	60% Danaklon Hycomfort
	Polypropylene 2.2 dtex x 40 mm
	+
	40% Courtaulds 18453
	Rayon, 1.5 den x 40 mm
Weight	
gsy	73.9
(gsm)	88.4
Caliper	
mils	36.9
(microns)	937.3
Dry Strip tensile	
MD, lbs/in	10.9
(lbs/cm)	4.3
CD, lbs/in	1.6
(lbs/cm)	0.6
Dry Strip elongation	
MD, %	49
CD,%	97.2
Absorbency	
sink time, seconds	2.96
absorbency, grams	47.41
absorbency, g/g	9.38

WE CLAIM:

1. A nonwoven composite comprising:

(a) a previously-bonded (prebonded) thermal-bond nonwoven fabric as a support layer, and

(b) at least one layer of carded fibers combined on one side of the support layer,

wherein the combined layers are thermally bonded together between heated calender rolls, so that at least the prebonded thermal-bond nonwoven fabric is subjected twice to bonding processes.

2. A nonwoven composite according to Claim 1, wherein the prebonded thermal-bond nonwoven fabric is combined with one layer of carded fibers to produce a bilaminate product.

3. A nonwoven composite according to Claim 2, wherein the combined layers are bonded between a calendar roll on a side in contact with the layer of carded fibers having a different bond pattern than that of the prebonded thermal bond nowoven fabric, and a calendar roll on a side in contact with the prebonded thermal bond nowoven fabric having a smooth surface, to produce a bilaminate product having dual textured sides.

4. A nonwoven composite according to Claim 1, wherein a second layer of carded fibers is combined on an opposite side of the support layer to produce a trilaminate product.

5. A nonwoven composite according to Claim 4, wherein the two carded fiber layers are composed of a blend of absorbent, resilient and soft fibers to produce a wipe product.

6. A nonwoven composite according to Claim 5, wherein the thermal-bond nonwoven fabric is composed of polypropylene fibers and has a basis weight in the range of 8 to 30 gsy, and the carded fiber layers are composed of a blend of 80% polypropylene fibers and 20% rayon fibers.

7. A nonwoven composite according to Claim 5, wherein the thermal-bond nonwoven fabric is composed of polypropylene fibers and has a basis weight in the range of 8 to 30 gsy, and the carded fiber layers are composed of a blend of 20% to 70% polypropylene fibers, 10% to 40% polyester fibers, and 20% to 40% rayon fibers.

8. A nonwoven composite according to Claim 1, wherein the combined layers are thermal-bonded between two calendar rolls both having engraved bond patterns.

9. A nonwoven composite according to Claim 1, wherein the combined layers are thermal-bonded between one calendar roll having an engraved bond pattern and the other roll having a smooth surface.

10. A nonwoven composite according to Claim 1, wherein the thermal-bond nonwoven fabric is composed of at least 40% or more cellulosic fibers blended with other fibers.

11. A nonwoven composite according to Claim 10, wherein the at least one carded fiber layer is composed of 50% to 0% cellulosic fibers with other fibers.

12. A nonwoven composite according to Claim 11, wherein the thermal-bond nonwoven fabric is composed of a greater percentage of cellulosic fibers than that of the carded fiber layer.

13. A nonwoven composite according to Claim 4, wherein the two carded layers are composed of a blend of absorbent, resilient and soft fibers to produce a skin care wipe product.

14. A nonwoven composite comprising:

(a) a previously-bonded (prebonded) nonwoven fabric as a support layer, and

(b) a top layer and a bottom layer of carded fibers combined on outer sides of the support layer,

wherein the combined layers are thermally bonded together between heated calender rolls, so that at least the prebonded nonwoven fabric is subjected twice to bonding processes.

15. A nonwoven composite according to Claim 14, wherein one layer of carded fibers is composed of a blend of fine denier, absorbent and resilient fibers, and the second layer of carded fibers is composed of a majority of non-absorbent, coarse denier fibers in order to produce a dual-sided product useful for applying cleaning lotion and scrubbing in skin care applications.

16. A nonwoven composite according to Claim 14, wherein the support layer is comprised of one of the following group of nonwoven fabrics: thermal-bond; spunbond; and spunbond-meltblown-spunbond (SMS) nonwoven fabric.

17. A nonwoven composite according to Claim 14, wherein one carded fiber layer is composed of fibers having a different color than those of the other carded fiber layer in order to provide a dual colored product.

18. A nonwoven composite comprising:

(a) an apertured film as a support layer, and

(b) a top layer and a bottom layer of carded fibers combined on outer sides of the support layer,

wherein the combined layers are thermally bonded together between heated calender rolls, and the apertured film is selected to have a masking effect which does not absorb liquid yet allows liquid to wick through from one side of the support layer to the other.

19. A nonwoven composite according to Claim 18, wherein one carded fiber layer is composed of colored fibers of a different color than those of the other carded fiber layer, and the masking effect of the apertured film allows the dual color appearance of the two sides to be maintained when the composite is saturated in liquid.

20. A nonwoven composite according to Claim 18, wherein one layer of carded fibers is composed of a blend of fine denier, absorbent and resilient fibers, and the second layer of carded fibers is composed of a majority of non-absorbent, coarse denier fibers in order to produce a dual-sided product useful for applying cleaning lotion and scrubbing in skin care applications.

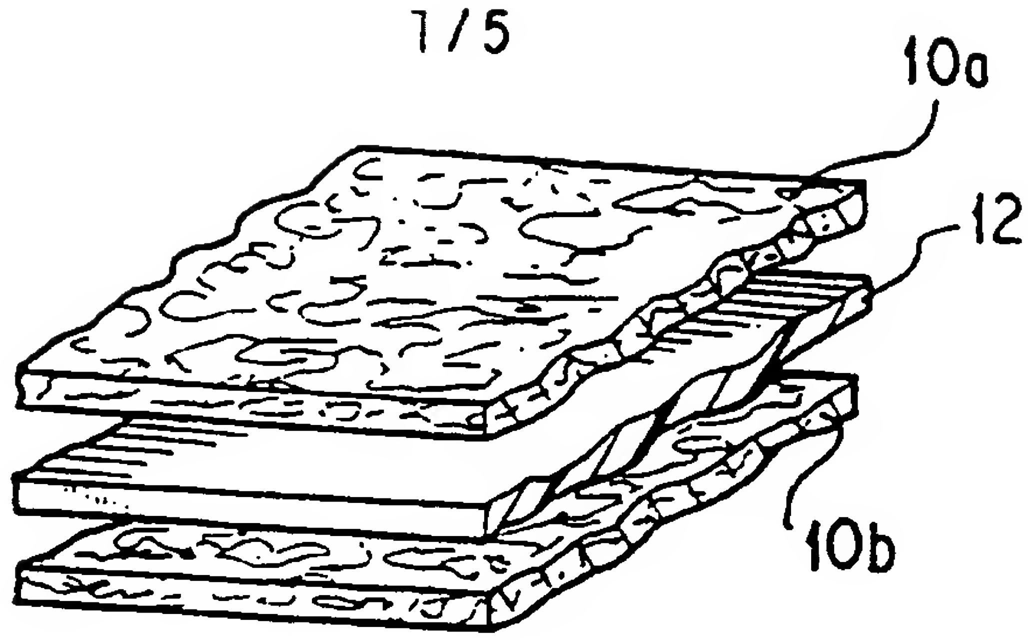


FIG. 1A

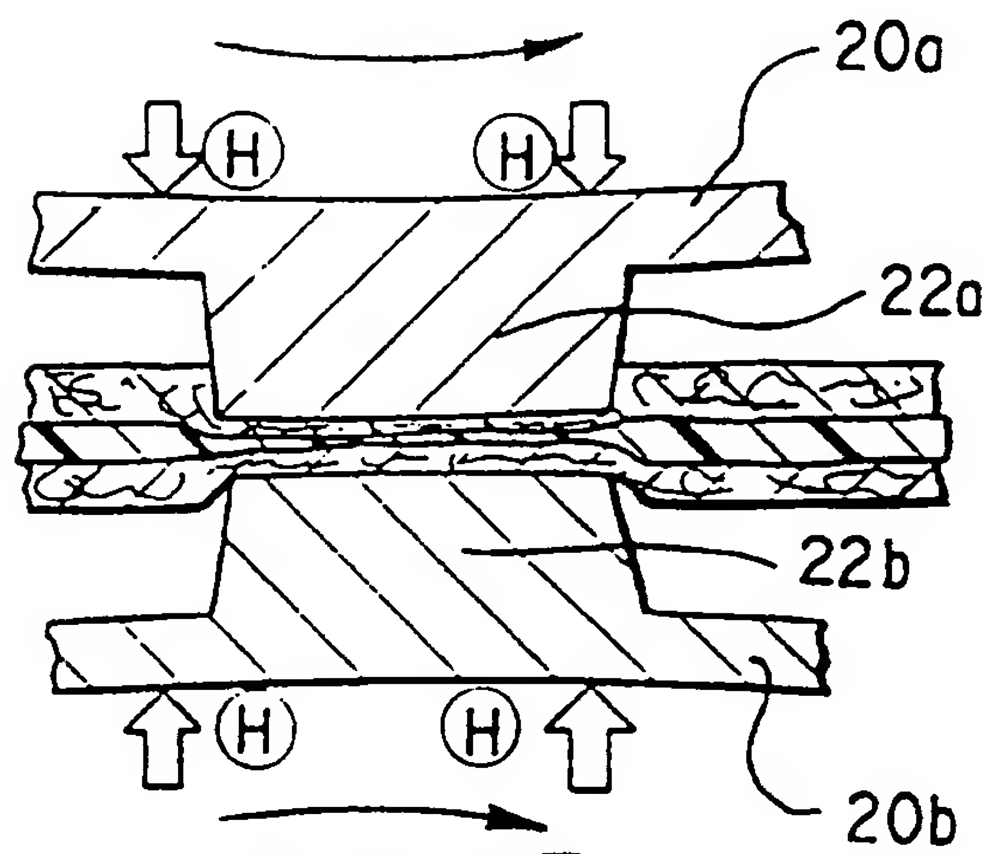


FIG. 1B

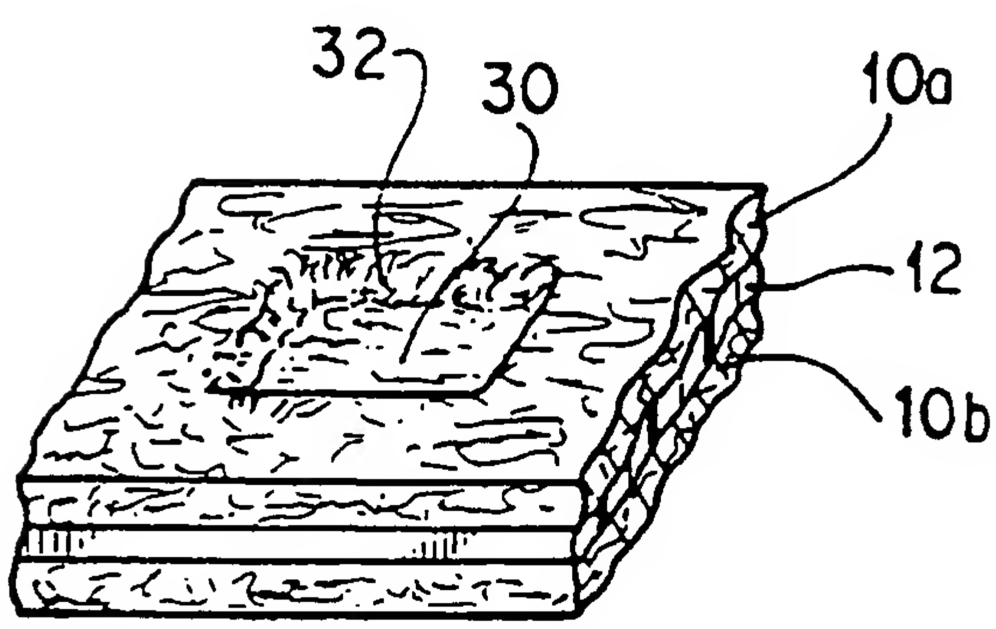


FIG. 1C

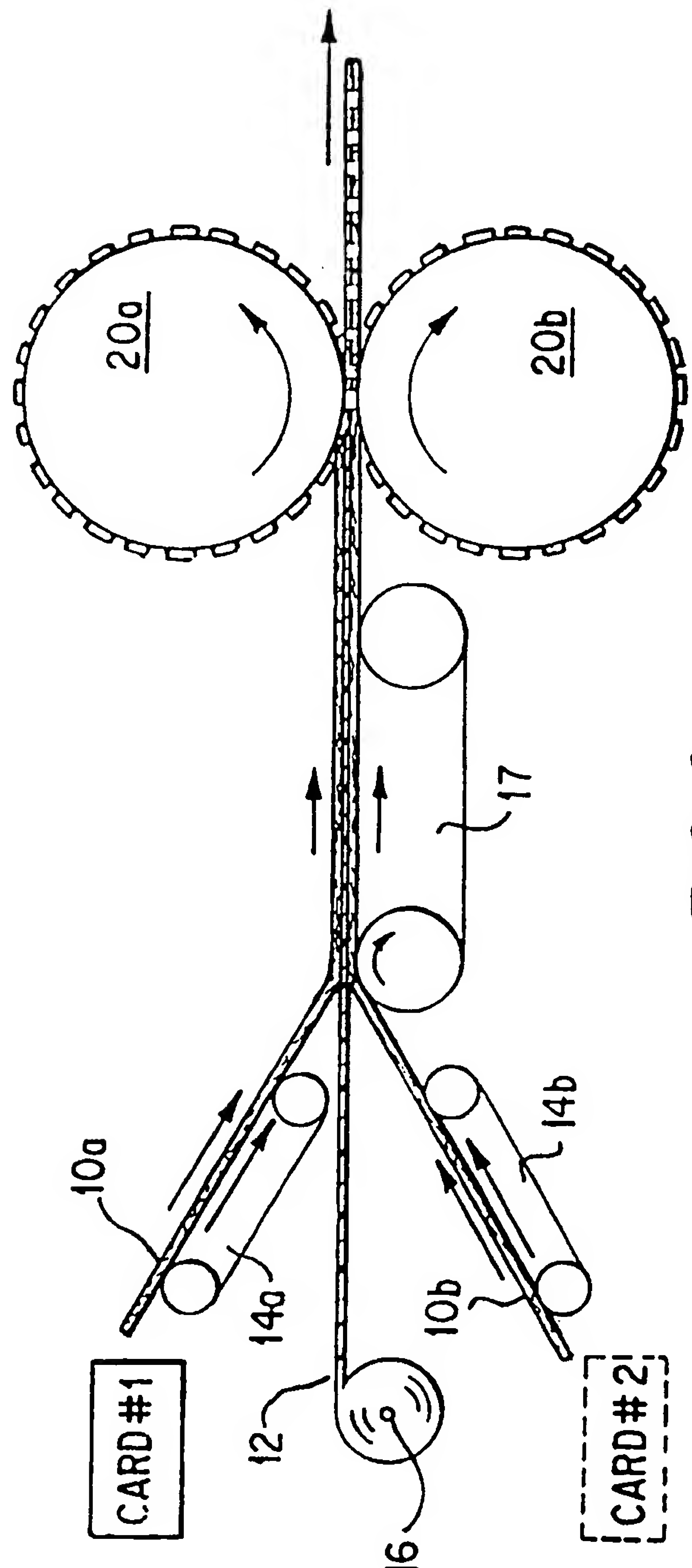


FIG. 2

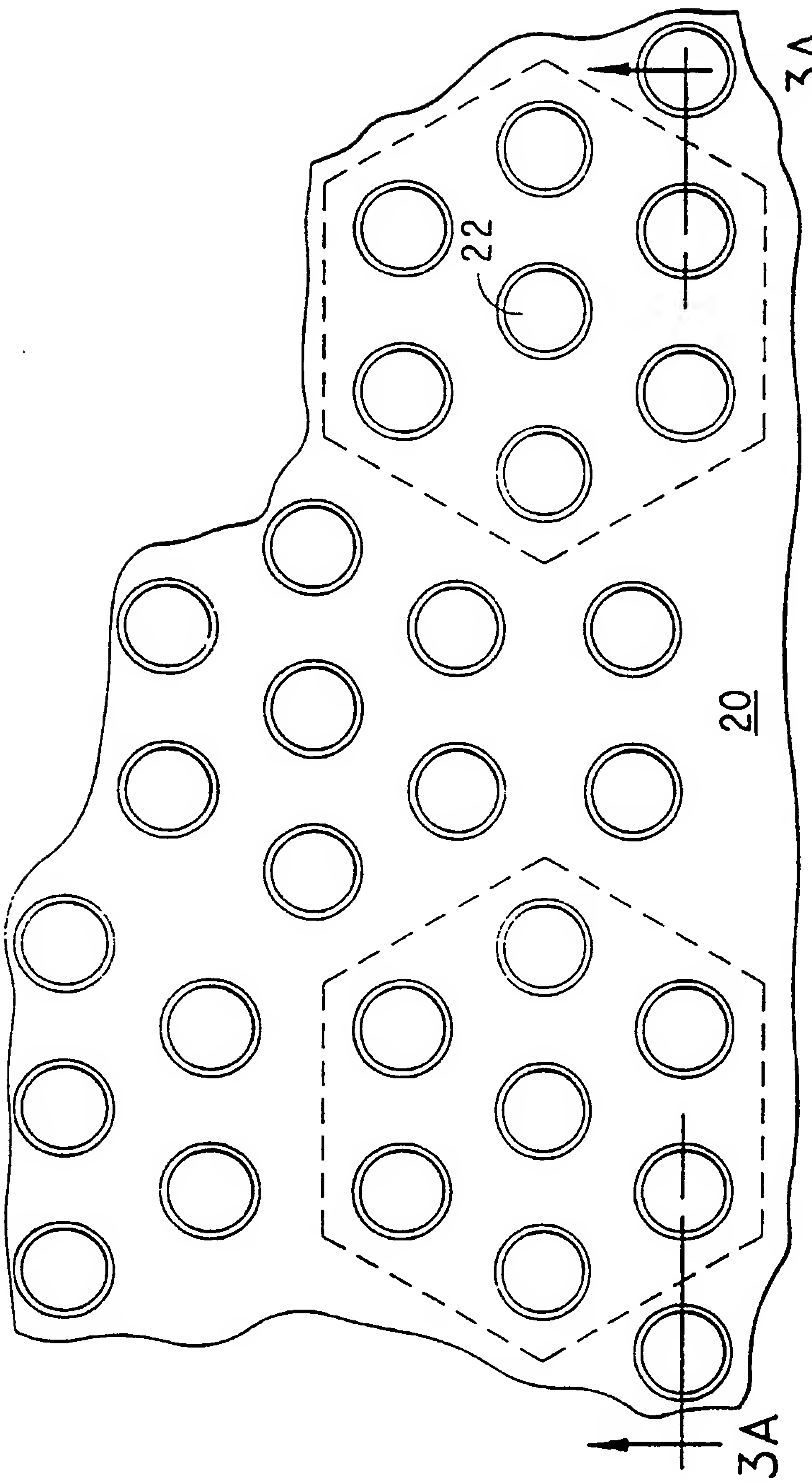


FIG. 3B

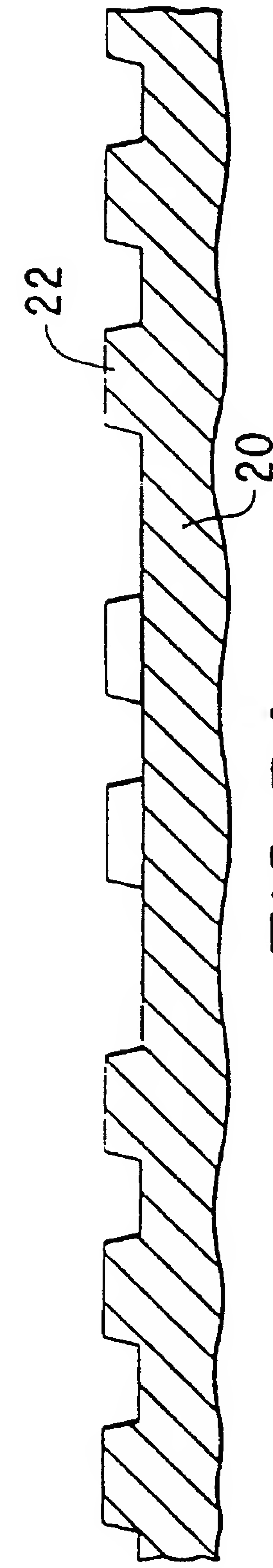


FIG. 3A

FIG. 4A

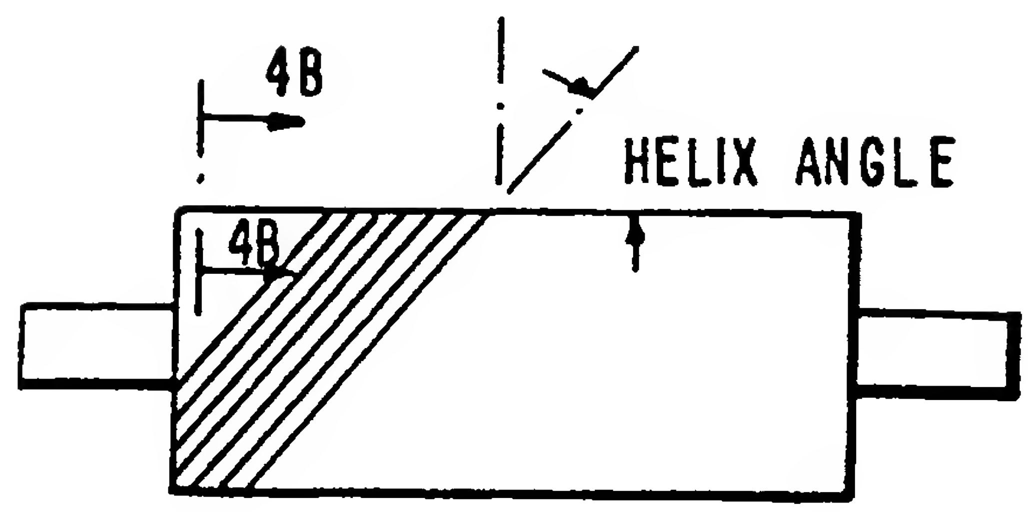


FIG. 4B

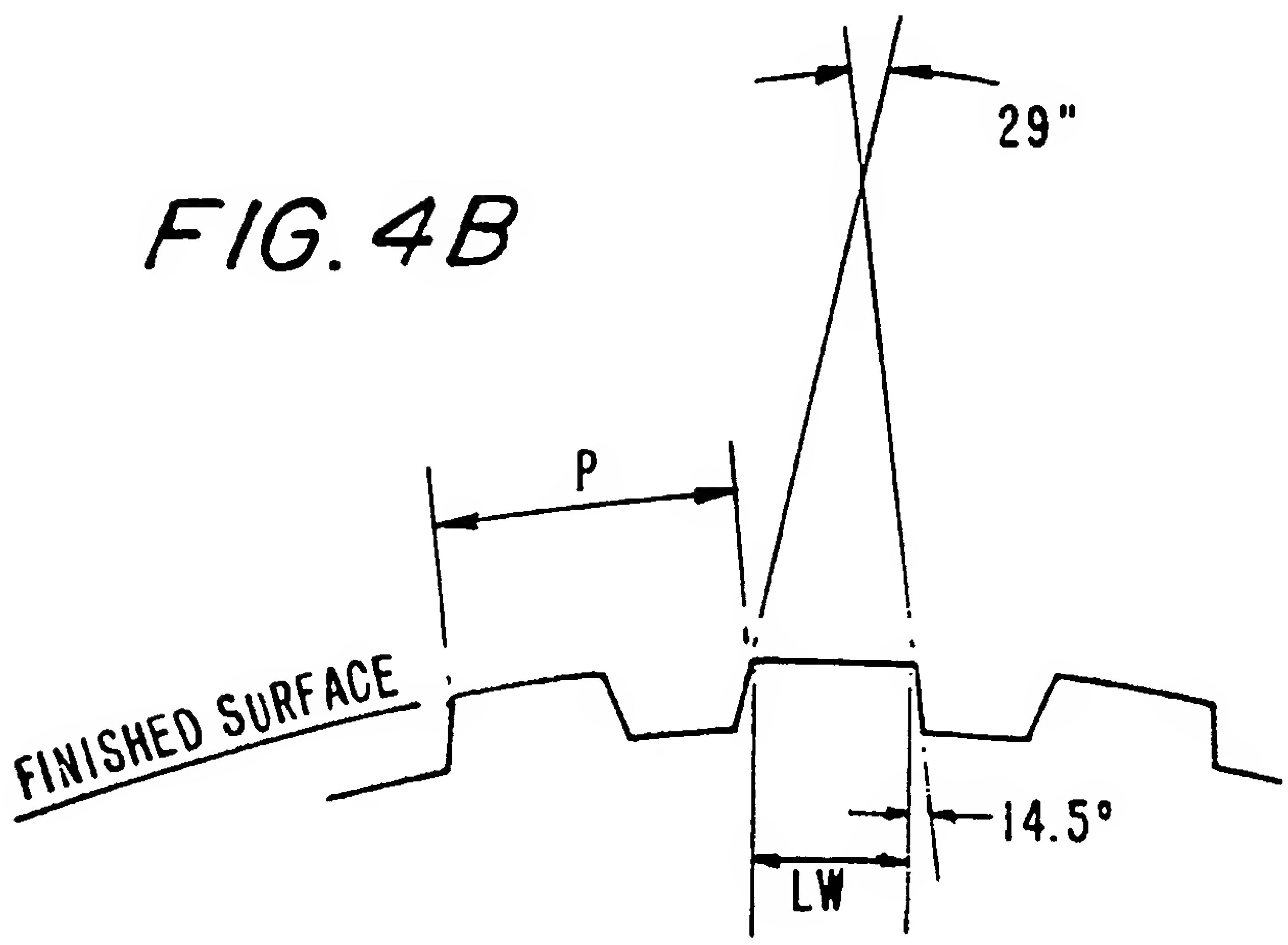
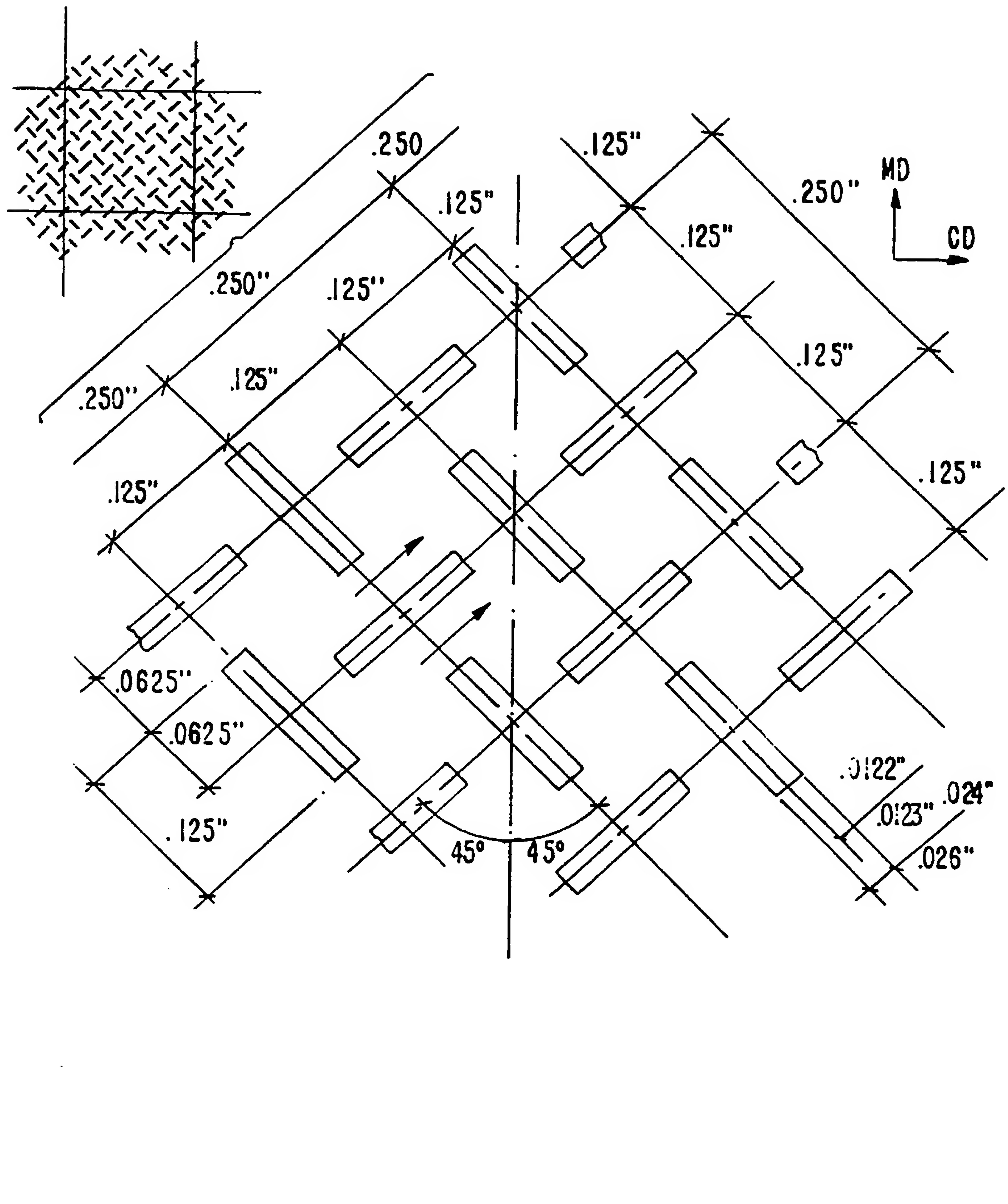


FIG. 5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.024"
.0123"
.026"
45°
45°

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/05507

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :B32B27/14
US CL :442/334, 346, 381, 385
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 442/334, 346, 381, 385

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 5,652,041 A (BUERGER et al) 29 July 1997, col. 2, lines 21-24 and col. 4, line 26 - col. 6, line 14.	14,16 -------------- 1-13,15,17- 20
Y	US 4,436,780 A (HOTCHKISS et al) 13 MARCH 1984, col. 3, lines 8-16.	1-13
Y	US 5,302,446 A (HORN) 12 April 1994, col. 4, lines 8-32.	15, 20
Y	US 4,725,473 A (VAN GOMPEL et al) 16 February 1988, col. 4, lines 10-22.	18-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 MAY 1999	15 JUN 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ELIZABETH M. COLE BRIAN A. HARDEN PARALEGAL SPECIALIST GROUP 1700 Telephone No. (703) 308-0037

Form PCT/ISA/210 (second sheet)(July 1992)*